PHYSICS

BOOKS - DC PANDEY PHYSICS (HINGLISH)

SOUND WAVES

Example

1. Corresponding to displacement equation,

$y = A\sin(kx + \omega t)$

of a longitudinal wave make its pressure and density wave also. Bulk modulus of the medium is B and density is p.

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2. (a) what is the displacemant amplitude for a sound wave having a frequency of $100Hz$ and a pressure amplitude of 10 pa? (b) The displacement amplitude of a sound wave of frequency $300Hz$ is 10^{-7} m. what is the pressure amplitude of this wave ? speed of

sound in airb is 340 ml s and density of a ir is $1.29kg/m^3$.

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3. Calculate the speed of longitudinal waves in the following gases at $0^\circ C$ and $1atm\left(=10^5pa\right)$:

(a) oxygen for which the bulk modulus is 1.41×10^5 pa and density is $1.43kg/m^3$.

(b) helium for which the bulk modulus is 1.7×10^5 pa and density is $0.18kg/m^3$.

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4. Find speed of sound in hydrogen gas at 27° . Ratio C_p/C_V for H_2 is 1.4 . Gas constant $R = 8.31 J/mol - K$.

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5. At what temperature will the speed of sound in hydrogen be the same aas in oxygen at 100° ? Molar Masses of oxygen and hydrogen are in the ratio $16:1$.

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6. For a person with normal hearing, the faintest sound that can be at a frequency of $400Hz$ has pressure amplitude of about 6.0×10^{-5} Pa . Calculate the corresponding intensity in W/m^2 . Take speed of sound in air as $344m/s$ and density of air $1.2kg/m^3$.

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7. Find intersity of sound in dB if its intensity in Wa/m^2 is 10^{-10}.

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8. A point source of sound emits a constant power with intensity inversely proportinal to the square of the distance from the source . By how many decible does the sound intensity level drops when you move from point P_1 to

P_2 ? Distance of P_2 from the source is two times the distance of source from P_1 .

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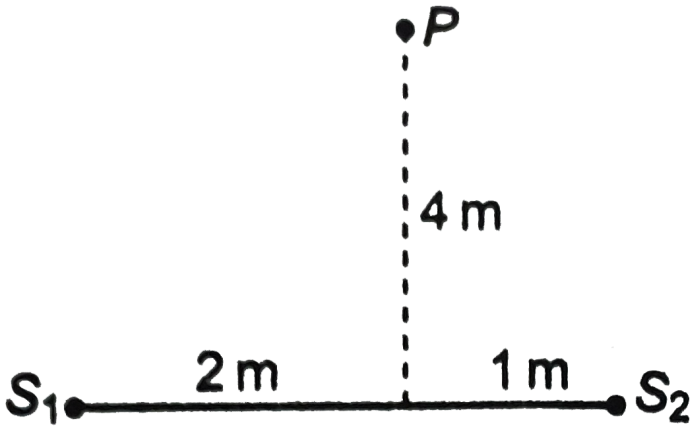
9. Two sound sources S_1 and S_2 emit pure sinussoidal waves in phase . If the speed of sound is $350m/s$, then



(a) for what frequencies does constructive interference occur at point P ?

(b) for what frequencies does destructive interference occur at point P ?

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10. Third overtone of a closed organ pipe is in unison with fourth harmonic of an open organ pipi . Find the ratio of the lengths of the pipes.

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11. An open organ pipe has a fundamental frequency of $300HZ$. The first overtone of a closed organ pipe has the same frequency as the first overtone of this open pipe . How long is each pipe ? (Speed of sound in air = $330m/s$)

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12. A cylindrical tube, open at both ends, has a fundamental frequency f in air . The tube is dipped vertically in water so that half of its

length is in water. The fundamental frequency of the air column is now

(a) $f/2$

(b) $3f/4$

(C) f

(d) $2f$

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13. A closed organ pipe of length L and an open organ pipe contain gass of densities ρ_1 and ρ_2, respectively. The compressibility of

gass are equal in both the pipes. Both the pipes are vibrating in their first overtone with same frequency . The length of the open orange pipe is

(a) $\frac{L}{3}$

$\frac{4l}{3}$

(c) $\frac{4l}{3}\sqrt{\frac{\rho_1}{\rho_2}}$

(d) $\frac{4l}{3}\sqrt{\frac{\rho_2}{\rho_1}}$

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14. Two tuning forks A and B produce 6 beats per second. Frequency of A is $300 H_Z$. When B is slightly loaded with wax, beat frequency decreases . Find original frequency of B .

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15. The string of a violin a note of $400 H_Z$ at its correct tension . The string is bit taut and produces 5 beats per second with a tuning

fork of frequency $400H_Z$. Find frequency of the note emitted by this taut string .

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16. Two tuning forks P and Q when set vibrating , give 4 beats per second. If a prong of the fork P is filed, the beats are reduced to 2 per second . If a prong of the fork P is filed, the beats are reduced to 2 per second . Determine the original frequency of P , if that of Q is $250H_Z$

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17. A car approaching a crossing C at a speed of $20m/s$ sounds a horn of frequency $500H_Z$ when $80m$ from the crossing . Speed of sound in air is $330m/s$. What frequency is heard by an observer (at rest) $60m$ from the crossing on the straight road which crosses car road at right angles ?

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18. A siren emitting a sound of frequency $1000 H_Z$ moves away from you towards a cliff at a speed of $10 m / s$.

(a) What is the frequency of the sounds, you hear coming directly from the sirven ?

(b) What is the frequency of sounds you hear reflected off the cliff . Speed of sound in air is $330 m / s$?

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19. A whistle of frequency $540 H_Z$ rotates in a circle of radius $2m$ at a linear speed of $30 m / s$. What is the lowest and highest frequency heard by an observer a long distance away at rest with respect to the centre of circle ? Take speed of sound of sound in air as $330 m / s$. Can the apparent frequency be ever equal to actual ?

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20. Two tuning forks with natural frequencies $340 H_Z$ each move relative to a stationary observer . One forks moves away from the oberver while the other moves towards him at the same speed . The observer hearts beats of frequency $3 H_Z$. Find the speed the of the tuning fork (velocity of sound in air is $340 m / s$) .

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Example Type 1

1. The first overtone of an open orgen pipe beats with the first ouertone of a closed orgen pipe with a beat frequency of $2.2H_Z$. The fundamental frequency of the closed organ pipe is $110H_Z$. Find the lengths of the pipes . Speed of sound in air $u = 330m/s$.

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2. A vibrating string of certain length l under a tension T resonates with a mode

corresponding to the first overtone (third harmonic) of an air column of length $75cm$ inside a tube closed at one end. The string also generates $4beats/s$ with a tuning fork of frequency n . Now when the tension of the string is slightly increased the number of beats reduces to 2 per second. Assuming the velocity of sound in air to $340m/s$, the frequency n the tuning fork in H_Z is

(a) 344

(b) 336

(c) 117.3

(d) 109.3

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3. Two identical straight wires are stretched so as to products $6beats/s$ when vibrating simultaneously. On changing the tension slightly in one of them, the beat frequency remains unchanged. Denoting by T_2 , T_2 the higher and the lower initial tension in the strings, then it could be said that that while making the above changes in tension

(a) T_2 was decreased

(b) T_2 was decreased

(c) T_1 was decreased

(d) $T_1$was decreased

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4. A sonometer wire under tension of $64N$ uibrating in its fundamental mode is in resonance with a uibrating tuning fork . The uibrating portion of the sonemether wire has a length of $10cm$ and mass of $1g$. The uibrating tuning fork is now moved away from the uibrating wire with a constant speed and

an observer standing near the sonometer hears one beat per second . Calculate the speed with which the tuning fork is moved , if speed of sound in air is $300m/s$.

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Example Type 2

1. A siren emitting a sound of frequency $1000H_Z$ moves away from you towards a cliff at a speed of $10m/s$.

(a) What is the frequency of the sound you hear coming directly from the sirven ?

(b) What is the frequency of sounds you hear reflected off the cliffb ?

(c) What beat frequency would you hear ? Take the speed of sound in air as $330 m / s$.

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2. A sound wave of frequency f travels horizontally to the right . It is teflected from a larger vertical plane surface moving to left

with a speed v. the speed of sound in medium is c

(a) The number of waves striking the surface per second is $\frac{f(c+v)}{c}$

(b) The wavelength of reflected wave is $\frac{c(c-v)}{f(c+v)}$

(c) The frequency of the reflected wave is $\frac{f((c+v))}{(c+v)}$

(d) The number of beats heard by a stationary listener to the left of the reflecting surface is $\frac{vf}{c-v}$

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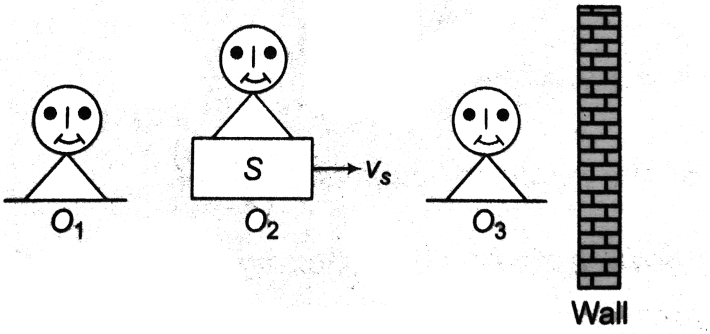
Type 2

1. A source of sound of frequency f is approaching towards a wall with speed v_s . Speed of sorce is v . Three obseruers O_1 , O_2 and O_3 are at different locations as shows . Find the beat frequency as obserued by three

different obseruers.



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Example Type 3

1. A tuning fork of $512 H_Z$ is used to produce resonance in a resonance tube expertiment.

The level of water at first resonance is $30.7cm$ and at second resonance is $63.2cm$. The error in calculating velocity of sound is

(a) $204.1cm / s$

(b) $110cm / s$

(c) $58cm / s$

(d) $280cm / s$

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2. In the experinment for the determinnation of the speed of sound in air using the

resonance column method, the length of the air column that resonates in the fu ndamental mode , with a tuning fork is $0.1m$. When this length is changed to $0.35m$, the same tuning fork resonates with the first overtone. Calculate the end correction.

(a) $0.012m$

(b) $0.0025m$

(c) $0.05m$

(d) $0.024m$

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3. A student is performing the experiment of resonance column. The diameter of the column tube is $4cm$. The frequence of the tuning fork is $512H_Z$. The air temperature is $38^\circ C$ in which the speed of sound is $336m/s$. The zero of first meter scale coincide with theb top nend of the resonance column tube . When the first resonance occurs, the reading of the water level in the column is

(a) $14.0cm$

(b) $15.2cm$

(c) $16.4cm$

(d) $17.6cm$

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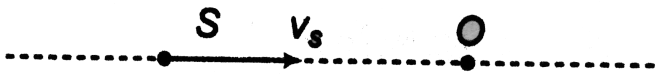
Example Type 4

1. A source of frequency f is moving towards the observer along the line SO with a constant velocity v_s as shown in figure. Plot f' versus t graph . Where f' is the changed frequency observed by the observer.



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2. A whistle emitting a sound of frequency $440h_z$ is tied to a string of $1.5m$ length and roated with an angular velocity of $20rad/s$ in the horizontal plane. Calculate the range of frequencies heard by an observer stationed at a larger distance from the whistle .(Speed of sound =$330m/s$) .

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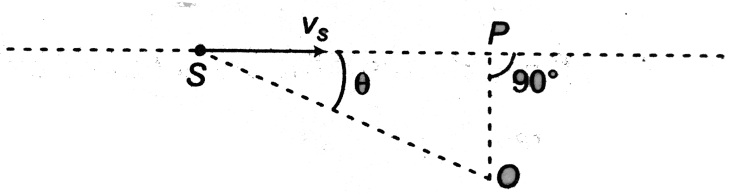
Type 5

1. Repeat example -11 if source does not move along the line SO.



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2. Three sound sources A, B and C have frequencies 400, 401 and $402 H_Z$, respectively.

Cacluated the number of beats noted per second.

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Miscellaneous Examples

1. The water level in a vertical glass tube $1.0m$ long can be adjusted to any position in the tube . A tuning fork vibrating at $660H_Z$ is held just over the open top end of the tube . At

what positions of the water level wil ther be in resonance? Speed of sound is $330m/s$.

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2. A tube $1.0m$ long is closed at one end. A stretched wire is placed near the open end. The wire is $0.3m$ long and a mass of $0.01kg$. It is held fixed at both ends and vibrates in its fundamental mode. It sets the air column in the tube into vibration at its fundamental frequency by resonance. Find

(a) the frequency of oscillation of the air column and

(b) the tension in the wire.

Speed of sound in air = $330 m / s$.

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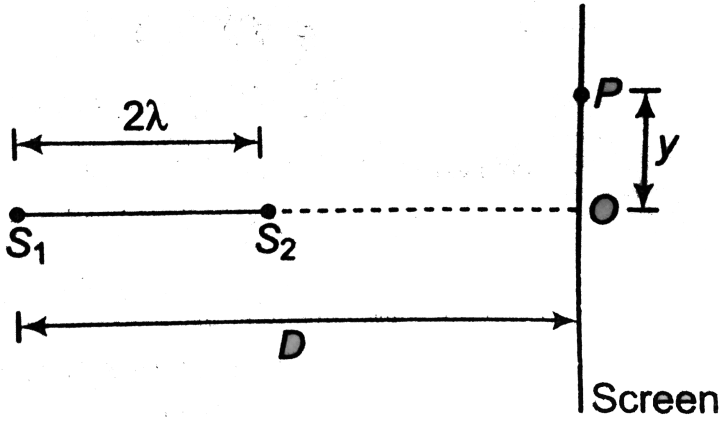
3. Two coherent narrow slits emitting sound of wavelength λ in the same phase are placed parallet to each other at a small separation of 2λ . The sound is delected by maving a delector on the screen at a distance

$D(>>\lambda)$ from the slit S_1 as shows in figure. Find the distance y such that the intensity at P is equal to intensity at O.



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4. A fighter plane moving in a vertical loop with constant speed of radius R. The center

of the loop is as a height h directly overhead of an observer standing on the ground. The observer receives maximum frequency of the sound produced by the plane when it is nearest to him . Find the speed of the plane. Velocity of sound in air is v .

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5. A source of sound of frequency $1000 H_Z$ moves unifornly along a straight line with velocity 0.8 times velocity of sound . An

observer is located at a distance $l = 250m$ from this line. Find

(a) the frequency of the sound at instant when the source is closest to the observer.

(b) the distance of the source when he observer no change in the frequency.

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6. The air column in a pipe closed at one end is made to vibrate in its second overtone by a tuning fork of frequency $440Hz$. The speed of

sound in air is $330 ms^{-1}$. End corrections may be neglected. Let P_0 denote the mean pressure at any point in the pipe, and ΔP the maximum amplitude of pressure variation.

(a) What the length L of the air column.

(b) What is the amplitude of pressure variation at the middle of the column?

(c) What are the maximum and minimum pressures at the open end of the pipe?

(d) What are the maximum and minimum pressures at the closed end of the pipe?

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7. At a distance $20m$ from a point source of sound the loudness level is $30dB$. Neglecting the damping, find

(a) the loudness at $10m$ from the source

(b) the distance from the source at which sound is not heard.

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8. A boat is travelling in a river with a speed $10m/s$ along the stream flowing with a speed

$2m/s$. From this boat , a sound transmitter is lowered into the river throught a rigid support. The wavelength of the sound emitted from the transmitter inside the water is $14.45mm$. Aassume that attenuation of sound in water and air is neglisible.

(a) What will be the frequency delected by a receiver kept inside the river downstream ?

(b) The transmitter and the reciver are now pulled up into air. The air is blowing with a speed $5m/s$ in the direction opposite the river stream. Determine the frequency of the sound delected by the reciver.

(Temperature of the air and water = $20^{\circ}C$, Density of river water = $10^{3}kg/m^{3}$, Bulk modulus of the water = $2.088 \times 10^{9}Pa$, Gas constant, $R = 8.31J/mol - K$, Mean molecular mass of air = $28.8 \times 10^{-3}kg/mol$, C_p/C_V for air = 1.4

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Level 1 Assertion And Reason

1. Assertion : A closed pipe and an open organ pipe are of same length. Then, neither of their frequencies can be same.

Reason : In the above case fundamental frequency of closed organ pipe will be two times the fundamental frequency of open organ pipe.

A. If both Asseration and Reason are true an dthe Reason is correct explanation of the Asseration.

B. If both Asseration and Reason are true but Reason is not the correct explanation of Asseration.

C. If Asseration is true , but the Reason is false.

D. If Asseration is false but the Reason is true.

Answer: C

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2. Assertion : A sound source is approaching towards a stationary observer along the tine joining them. Then , apparent frequency to the observer will go on increasing.

Reason : If there is no relative motion between source and observer , apparent frequency is equal to the actual frequency.

A. If both Asseration and Reason are true an dthe Reason is correct explanation of the Asseration.

B. If both Asseration and Reason are true but Reason is not the correct explanation of Asseration.

C. If Asseration is true , but the Reason is false.

D. If Asseration is false but the Reason is true.

Answer: D

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3. Assertion : In longitudinal wave pressure is maximum at a point where displacement is zero .

Reason : There is a phase difference of $\frac{\pi}{2}$ between $y(x,t)$ and $\Delta P(x,t)$ equation in case of longitudinal wave.

A. If both Asseration and Reason are true an dthe Reason is correct explanation of the Asseration.

B. If both Asseration and Reason are true but Reason is not the correct explanation of Asseration.

C. If Asseration is true , but the Reason is false.

D. If Asseration is false but the Reason is true.

Answer: D

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4. Assertion : A train is approachinng towards a hill . The driver of the train will hear beats.

Reason : Apparent frequency of reflected sound observerd by driver will be more than the frequency of direct sound observered by him.

A. If both Asseration and Reason are true an dthe Reason is correct explanation of the Asseration.

B. If both Asseration and Reason are true but Reason is not the correct explanation of Asseration.

C. If Asseration is true , but the Reason is false.

D. If Asseration is false but the Reason is true.

Answer: A

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5. Assertion : Sound level increases linearly with intensity of sound.

Reason : If intensity of sound is doubled, sound level increases approximately $3dB$.

A. If both Asseration and Reason are true an dthe Reason is correct explanation of the Asseration.

B. If both Asseration and Reason are true but Reason is not the correct explanation of Asseration.

C. If Asseration is true , but the Reason is false.

D. If Asseration is false but the Reason is true.

Answer: D

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6. Assertion : Speed of sound in gass is independent of pressure of gas.

Reason : With increase in temperature of gas speed of sound will increase.

A. If both Asseration and Reason are true an dthe Reason is correct explanation of the Asseration.

B. If both Asseration and Reason are true but Reason is not the correct explanation of Asseration.

C. If Asseration is true , but the Reason is false.

D. If Asseration is false but the Reason is true.

Answer: D

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7. Assertion : Beat frequency between two tuning forks a and B is $4H_Z$. Frequency of A is greater then the frequency of B. When a is loaded with wax, beat frequency may increase or decrease.

Reason : When a tuning fork is loaded with wax, its frequency decreases.

A. If both Asseration and Reason are true an dthe Reason is correct explanation of the Asseration.

B. If both Asseration and Reason are true but Reason is not the correct explanation of Asseration.

C. If Asseration is true , but the Reason is false.

D. If Asseration is false but the Reason is true.

Answer: B

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8. Assertion : Two successive frequency of an organ pipe are $450H_Z$ and $750H_Z$. Then, this pipe is a closed pipe.

Reason : Fundamental frequency of this pipe is $150h_Z$.

A. If both Asseration and Reason are true an dthe Reason is correct explanation of the Asseration.

B. If both Asseration and Reason are true but Reason is not the correct explanation of Asseration.

C. If Asseration is true , but the Reason is false.

D. If Asseration is false but the Reason is true.

Answer: B

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9. Assertion : Fundamental frequency of a narrow pipe is more.

Reason : According to laplace end correction if radius of pipe is lass, frequency should be more.

A. If both Asseration and Reason are true an dthe Reason is correct explanation of

the Asseration.

B. If both Asseration and Reason are true but Reason is not the correct explanation of Asseration.

C. If Asseration is true , but the Reason is false.

D. If Asseration is false but the Reason is true.

Answer: A

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10. Assertion : In the experiment of finding speed of sound by resonance tube method, as the level of water is lowered, wavelength increases.

Reason : By lowering the water level number of loops increases.

A. If both Asseration and Reason are true an dthe Reason is correct explanation of the Asseration.

B. If both Asseration and Reason are true but Reason is not the correct explanation of Asseration.

C. If Asseration is true , but the Reason is false.

D. If Asseration is false but the Reason is true.

Answer: D

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Level 1 Objective

1. Velocity of sound in vacuum is

A. equal to $330 m / s$

B. grater then $330 m / s$

C. less then $330 m / s$

D. None of these

Answer: D

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2. Longitudinal waves are possible in

A. solids

B. liquids

C. gases

D. All of these

Answer: D

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3. If the fundamental frequency of a pipe closed at one is $512H_Z$. The frequency of a pipe of the same dimension but open at both ends will be

A. $1024h_Z$

B. $512H_Z$

C. $256H_Z$

D. $128H_Z$

Answer: A

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4. The temperature at which the velocity of sound in oxygen will be same as that of nitrogen at $15^\circ C$ is

A. $112^\circ C$

B. $72^\circ C$

C. $56^\circ C$

D. $17^\circ C$

Answer: C

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5. A closed organ pipe is excited to vibrate in the third overtone. If is obertone that there are

A. three nodes and three antinodes

B. three nodes and four antinodes

C. four nodes and three antinodes

D. four nodes and four antinodes

Answer: D

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6. When temperature is increases, the frequency of organ pipe

A. increases

B. becreases

C. remains same

D. Nothing can be said

Answer: A

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7. When a sound wave travels from water to air , it

A. bends towards normal

B. bends away from normal

C. may bend in any direction

D. date insufficient

Answer: A

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8. A closed organ pipe and an open organ pipe are tuned to the same fundamental frequency. The ratio of their lengths is

A. $1:2$

B. $2:1$

C. $1:4$

D. $4:1$

Answer: A

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9. A sonometer wire under a tension of $10kg$ weight is in unsion with a tuning fork of frequency $320H_Z$. To make the wire vibrate in unsion with a tuning fork of frequency $256h_Z$, the tension should be altered by

A. $3.6kg$ decreased

B. $3.6kg$ increased

C. $6.4kg$ decreased

D. $6.4kg$ increased

Answer: A

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10. A tuning fork of frequency $256h_Z$ is moving towards a well with a velocity of $5m/s$. If the speed of sound is $330m/s$, then the number of beats heard per second by a stationary observer lying between tuning fork and the well is

A. 2

B. 4

C. zero

D. 8

Answer: C

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11. Two sound waves of wavelength $1m$ and $1.01m$ in a gas produce 10 beats in 3s. The velocity of sound in the gas is

A. $330m/s$

B. $337m/s$

C. $360m/s$

D. $300m/s$

Answer: B

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12. when a source is going away from a stationary observer with the velocity equal to that of sound in air , then the frequency heard

by observer is n times the original frequency .

The value of n is

A. 0.5

B. 0.25

C. 1.0

D. No sound is heard

Answer: A

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13. When interference is produced by two progressive waves of equal frequencies, then the maximum intensity of the resulting sound are N times the intensity of each of the component waves. The value of N is

A. 1

B. 2

C. 4

D. 8

Answer: C

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14. A tuning fork of frequency $500 H_Z$ is sounded on a resonance tube . The first and second resonances are obtined at $17 cm$ and $52 cm$. The velocity of sound is

A. $170 m / s$

B. $350 m / s$

C. $520 m / s$

D. $850 m / s$

Answer: B

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15. A vehicle , with a horn of frequency n is moving with a velocity of $30m/s$ in a direction prependicular to the straight line joining the observer and the vehicle . The observer perceives the sound to have a grequency $(n+n_1)$. If the sound velocity in air is $330m/s$, then

A. $n_1 = 10n$

B. $n_1 = 0$

C. $n_1 = 0.1n$

D. $n_1 = -0.1n$

Answer: B

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16. How many frequencies below $1kH_Z$ of natural oscillations of air column will be

produced if a pipe of length $1m$ is closed at one end? [velocity of sound in air is $340m/s$]

A. 3

B. 6

C. 4

D. 8

Answer: B

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17. a sound source emits frequency of $180h_Z$ when moving towards a rigid wall with speed $5m/s$ and an observer is moving away from with speed $5m/s$. Both source and observer moves on a straight line which is perpendicular to the wall. The number of beatd per second heard by the observer will be [speed of sound = $335m/s$]

A. $5beats/s$

B. $10beats/s$

C. $6beats/s$

D. $8beats/s$

Answer: A

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18. Two sound waves of wavelengths λ_1 and $\lambda_2(\lambda_2 > \lambda_1)$ produces $nbeats/s$, the speed of sound is

A. $\frac{n\lambda_1\lambda_2}{\lambda_2 - \lambda_1}$

B. $n\left(\frac{1}{\lambda_1} - \frac{1}{\lambda_2}\right)$

C. $n(\lambda_2 - \lambda_1)$

D. $n(\lambda_2 + \lambda_1)$

Answer: A

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19. $A, B$and C are three tuning forks. Frequency of A is $350H_Z$. Beats produced by A and B are $5/s$ and by B and C are $4/s$. When a wax is put on A beat frequency between A and B is $2H_Z$ and between a and

C is $6H_z$. Then, frequency of B and C respectively , are

A. $355H_Z, 349h_Z$

B. $345H_Z$, $341H_Z$

C. $355H_Z$, $341H_Z$

D. $345H_Z, 349H_Z$

Answer: A::B::C::D

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20. The first resonance length of a resonance tube is $40cm$ and the second resonance length is $122cm$. The third resonance length of the tube will be

A. $200cm$

B. $202cm$

C. $203cm$

D. $204cm$

Answer: D

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21. Two identical wires are streched by the same tension of $100N$ and each emits a note of frequency $200H_Z$. If the tension in one wire is increased by $1N$, then the beat frequency is

A. $2H_Z$

B. $\frac{1}{2}H_Z$

C. $1H_Z$

D. None of these

Answer: C

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22. A tuning fork of frequency $340Hz$ is excited and held above a cylindrical tube of length $120cm$. It is slowly filled with water. The minimum height of water column required for resonance to be first heard(Velocity of sound $= 340ms^{-1}$) is.

A. $25cm$

B. $95cm$

C. $75cm$

D. $45cm$

Answer: D

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23. In a closed end pipe of length $105cm$, standing waves are set up corresponding to the third overtone . What distance from the

closed end, amongst the following is a pressure node?

A. $20cm$

B. $60cm$

C. $85cm$

D. $45cm$

Answer: D

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24. Oxygen is 16 times heavier than hydrogen. At NTP equal volumn of hydrogen and oxygen are mixed. The ratio of speed of sound in the mixture to that in hydrogen is

A. $\sqrt{8}$

B. $\sqrt{\frac{1}{8}}$

C. $\sqrt{\frac{2}{17}}$

D. $\sqrt{\frac{32}{17}}$

Answer: C

Watch Video Solution

Watch video solution

25. A train is moving towards a stationary observer. Which of the following curve best represents the frequency recived by observer f aas afunction of time?

A. `(#3DCP_V03_C19_E01_035_Q01.png"

width="30%">

B. `(#3DCP_V03_C19_E01_035_Q02.png"

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C. `(#3DCP_V03_C19_E01_035_Q03.png"

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D. `(#3DCP_V03_C19_E01_035_Q04.png"

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Answer: B

Watch Video Solution

26. A closed organ pipe and an open organ pipe of same length produce 4 beats when they are set into vibrations simultaneously. If

the length of each of them were twice their initial lengths, the number of beats produced will be

A. 2

B. 4

C. 1

D. 8

Answer: A

Watch Video Solution

27. One train is approaching an observer at rest and another train is receding from him with the same velocity $4m/s$. Both trains blow whistles of same frequency of $243H_Z$. The beat frequency in H_Z as heard by observer is (speed of sound in air = $320m/s$)

A. 10

B. 6

C. 4

D. 1

Answer: B

Watch Video Solution

28. Speed of sound in air is $320m/s$. A pipe closed at one end has a length of $1m$ and there is another pipe open at both ends having a length of $1.6m$. Neglecting end corrections, both the air columns in the pipes can resonate for sound of frequency

A. $80H_Z$

B. $240h_Z$

C. $320h_Z$

D. $400H_Z$

Answer: D

Watch Video Solution

29. Four sources of sound each of sound level $10dB$ are sounded together in phase , the resultant intensity level will be $(\log_{10} 2 = 0.3)$

A. $40dB$

B. $26dB$

C. $22dB$

D. $13dB$

Answer: C

Watch Video Solution

30. A longitudinal sound wave given by $p = 2.5 \sin. \frac{\pi}{2}(x - 600t)$ (p is in N/m^2 , x is in metal and t is in second) is sent down a

closed a orgain pipe. If the pipe vibrates in its second overtone, the length of the pipe is

A. $6m$

B. $8m$

C. $5m$

D. $10m$

Answer: C

Watch Video Solution

31. Sound waves of frequency $600H_Z$ fall normally on perfectly reflecting wall. The distance from the wall at which the air particles have the maximum amplitude of vibration is (speed of sound in air = $330m/s$)

A. $13.75cm$

B. $40.\ 25cm$

C. $70.5cm$

D. $60.75cm$

Answer: A

Watch Video Solution

32. The wavelength of two sound waves are $49cm$ and $50cm$, respectively . If the room temprature is $30^\circ C$, then the number of beats producted by them is approximatelt (velocity of sound in air at $30^\circ C = 332m/s$)

A. 6

B. 10

C. 13

D. 18

Answer: C

Watch Video Solution

33. Two persons A and B , each carring a source of frequency $300H_Z$, are standing a few metre apart. A starts moving towards B with velocity $30m/s$. If speed of sound is $300m/s$, which of the following is true?

A. (a) Number of beats heard by A is heigher than that heard by B

B. (b) The number of beats heard by B are $30H_Z$

C. Both (a) and (b) are correct

D. Both (a) and (b) are wrong

Answer: D

Watch Video Solution

34. A fixed source of sound emitting a certain frequency appears as f_a when the observer is approaching the source with v_0 and f_r when the observer recedes from the source with the same speed. The frequency of source is

A. $\frac{f_r + f_a}{2}$

B. $\frac{f_r - f_a}{2}$

C. $\sqrt{f_a f_r}$

D. $\frac{2 f_r f_a}{f_a + f_a}$

Answer: A

Watch Video Solution

Level 1 Subjective

1. Dentermine the speed of sound waves in water , and find the wavelength of a wave having a frequency of $242H_Z$. Take $B_{water} = 2 \times 10^9 Pa.$

A. $5.84m$

B. $11.68m$

C. $1414m$

D. none

Answer: A

Watch Video Solution

2. If the source and reciver are at rest realative to each other but the wave medium is moving realative to them, will the reciver delect wavelength or frequency shift.

Watch Video Solution

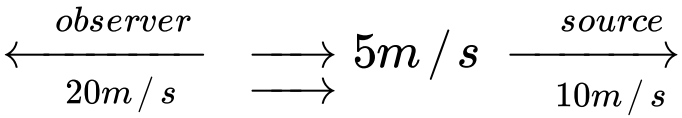
3. Using the fact that hydrogen gas consister of diatomic molecules with $M = 2kg/K - mol$. Find the speed of sound in hydrogen at $27^\circ C$.

Watch Video Solution

4. About how many times more intense will the normal ear perceiver a sound of $10^6 W/m^2$ than one of $10^9 W/m^2$?

Watch Video Solution

5. A $300 H_Z$ source, an observer and a wind are moving as shows in the figure with respect to the ground. What frequency is heard by observer ? Take speed of sound in air = $340 m / s$.



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6. A person standing between two parallel hills fires a gun. He hears the first echo after $\frac{3}{2}$ s, and a second echo after $\frac{5}{2}$ s. If speed of sound is $332m/s$, Calculate the distance between the hills. When will he hear the third echo?

Watch Video Solution

7. Helium is a monatomic gas that has a density of $0.179kg/m^3$ at a pressure of $76cm$ of mercury and a temperature of $0^\circ C$. Find

the speed of compressional waves (sound) in helium at this temperature and pressure.

Watch Video Solution

8. (a) In a liquid with density $1300 kg/m^3$, longitudinal waves frequency $400 H_Z$ are found to have wavelength $8.00 m$. Calculate the bulk modulus of the liquid. (b) A metal bar with a length of $1.50 m$ has density $6400 kg/m^3$. Longitudinal sound waves take 3.90×10^{-4} s to travel from one end of the

bar to the other. What is young's modulus for this metal?

Watch Video Solution

9. What must be the stress (F/A) in a stretched wire of a material whose Young's modulus is Y for the speed of lonitudinal waves equal to 30 times the speed of transverese waves?

Watch Video Solution

10. A gas is a mixture of two parts by volume of hyprogen and part by volume of nitrogen at STP. If the velocity of sound in hydrogen at $0^{\circ}C$ is $1300m/s$. Find the velocity of sound in the gaseous mixure at $27^{\circ}C$.

Watch Video Solution

11. The explosion of a fire cracker in the air at the a heigth of $40m$ produced a $100dB$ sound level at ground below. What is the

instantaneous total radiated power? Assuming that it radiates as a point source.

Watch Video Solution

12. (a) What is the intensity of a $60dB$ sound ? (b) If the sound level is $60dB$ close to a speaker that has an area of $120cm^2$. What is the acoustic power output of the speaker?

Watch Video Solution

13. (a) By what factor must the sound intensity be increased the sound intensity level by $13.0dB$? (b) Explain why you do not need to know the original sound intersity ?

Watch Video Solution

14. The speed of a certain compressional wave in air at standard temperature and pressure is $330m/s$. A point source of frequency $300H_Z$ radiates energy uniformly in all directions at

the rate of 5 Watt. (a) What is the intensity of the wave at a distance of $20m$ from the source? (b) What is the amplitude of the wave there? [Density of air at $STP = 1.29kg/m^3$]

A. $1.15 \times 10^6 m$

B. $1.15 \times 10^{-6} m$

C. $1.15 \times 10^{-6} cm$

D. none

Answer: B

Watch Video Solution

15. What is the amplitude of motion for the air in the path of a $60dB$, $800H_Z$ sound wave? Assume that $\rho_{air} = 1.29kg/m^3$ and $v = 330m/s$.

Watch Video Solution

16. A rock band give rise to an average sound level of $102dB$ at a distance of $20m$ from the center of the band . As an approximation , assume that the band radiates sound equally

into a sphere. What is the sound power output of the band?

Watch Video Solution

17. If it wave possible to generate a sinusoidal $300H_Z$ sound wave in air that has a displacement amplitude of $0.200mm$. What would be the sound level ? (Assume $v = 330m/s$ and $\rho_{air} = 1.29kg/m^3$)

Watch Video Solution

18. (a) A longitudinal wave propagating in a water-filled pipe has intensity $3.00 \times 10^{-6} W/m^2$ and frequency $3400 H_Z$. Find the amplitude A and wavelength λ of the wave . Water has density $1000 kg/m^3$ and bulk modulus $2.18 \times 10^9 Pa$. (b) If the pipe is filled with air at pressure 1.00×10^5 Pa and density $1.20 kg/m^3$, What will be the amplitude A and wavelength λ of a longitudinal wave the same intensity and frequency as in part (a) ? (c) In which fluid is the amplitude larger, water or air? What is the ratio of the two amplitude ?

Why is this ratio so different from/ Conider air as diatomic.

Watch Video Solution

19. For a person with normal hearing, the faintest sound that can be heard at a frequency of $400Hz$ has a pressure amplitude of about 6.0×10^{-5} Pa . Calculate the corresponding intensity and sound intensity lavel at $20^{\circ}C$. (Assume $v = 330m/s$ and $\rho_{air} = 1.29kg/m^3$).

Watch Video Solution

20. find the fundamental frequency and the frequency of the first two overtones of a pipe $45.0cm$ long. (a) If the pipe is open at both ends. (b) If the pipe is closed at one end. Use $v = 344m/s$.

Watch Video Solution

21. Write the equation for the fundamental standing sound waves in a tube that is open

at both ends. If the tube is $80cm$ long speed of wave is $330m/s$. Represent the amplitude of the wave at an antinode by A .

Watch Video Solution

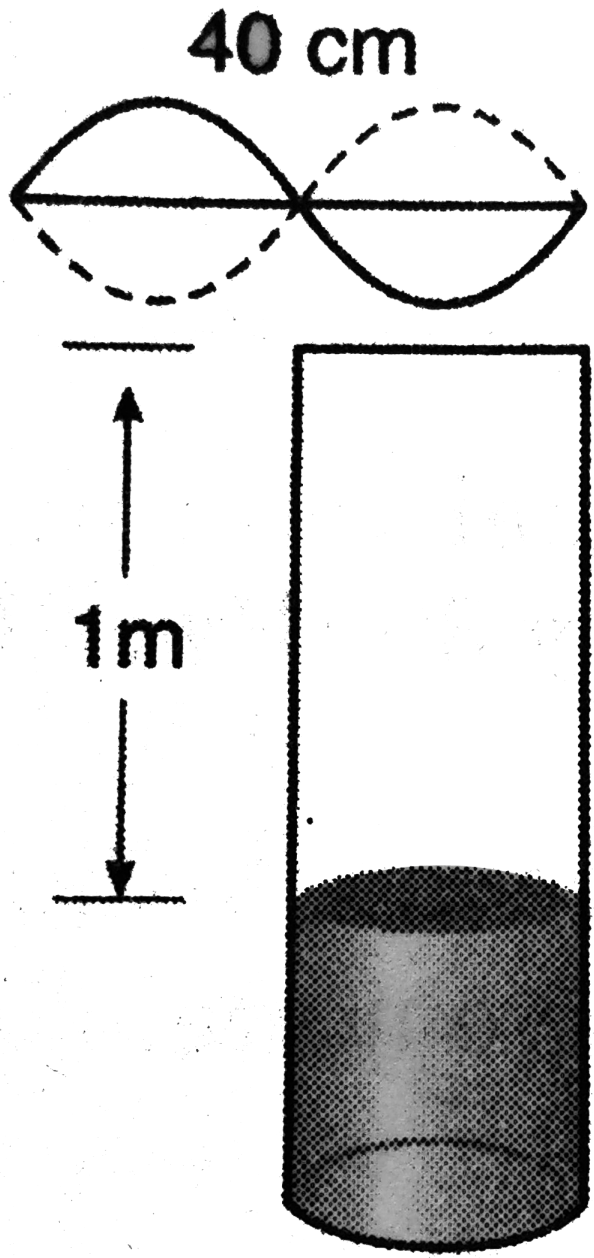
22. A long glass tube is held vertically , dipping into water, while a tuning fork of frequency $512H_Z$ is respeatedly struck and held over the open end. Strong resonance is obtained, when the length of the tube above the surface of water is $50cm$ and again $84cm$, but not at any

intermediate point. Find the speed of sound of sound in air and next length of the air column for resonance.

Watch Video Solution

23. A wire of length $40cm$ which has a mass of 4 g oscillates in its second harmonic and sets the air column in the tube to vibrations in its funrations in its fundamental mode as shows in figure. Assuming the speed of sound in air

as $340 m / s$. Find the tension in the wire.



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24. In a resonance tube experiment to determine the speed of sound in air, a pipe of diameter $5cm$ is used . The column in pipe resonates with a tuning fork of frequency $480H_Z$ when the minimum length of the air column is $16cm$. Find the speed in air column at room temperature.

Watch Video Solution

25. On a day when the speed is $345 m / s$, the fundamental frequency of a closed organ pipe is $220 H_Z$. (a) How long is this closed pipe? (b) The second overtone of this pipe has the same wavelength as the third harmonic of an open pipe . How long is the open pipe ?

Watch Video Solution

26. A closed organ pipe is sounded near a guitar, causing one of the string to vibrate with large ampulitude . We vary the tension of

the string until we find the maximum amplitude. The string is $80\,\%$ aas long as the closed pipe. If both the pipe and the string vibrate at their fundamental frequency, calculate the ratio of the wave speed on the string to the speed of sound in air. s

Watch Video Solution

27. A police siren emits a sinusoidal wave with frequency $f_S = 300 H_z$. The speed of the sound is $340 m / s$. (a) Find the wavelength of

the waves if siren is at rest in the air . (b) If the siren is moving at $30 m / s$, Find the wavelength of the waves ahead of and behind the source.

Watch Video Solution

28. Two identical violin strings, when in true and stretched with same tension , have a fundamental frequency of $440.0 H_Z$. One of the string is retuned by adjusting its tension . When this is done, 1.5 beats per second are

heard when both strings are plucked simultaneously. (a) What are the possible fundamental frequencies of the retuned string? (b) by what fractional amount was the string tension changed if it was (i) increased (ii) decreased?

Watch Video Solution

29. A swimming duck paddles the water with its feet once every 1.6 s, producing surface waves with this period. The duck is moving at

constant speed in a pond where the speed of surface waves is $0.32m/s$, and the crests of the waves ahead of the duck are spaced $0.12m$ apart. (a) What is the duck's speed? (b) How far apart are the crests behind the duck?

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30. A railroad train is travelling at $30.0m/s$ in still air. The frequency of the note emitted by the train whistle is $262H_Z$. What frequency is heard by a passenger on a train moving in the

opposite direction to the first at $18.0 m / s$ and (a) approaching the first? (b) receding from the first? Speed of sound in air = $340 m / s$.

Watch Video Solution

31. A boy is walking away from a well at a speed of $1.0 m / s$ in a direction at right angles to the wall. As he walks, he below a whistle steadily. An observer towards whom the boy is walking hears 4.0 beats per second. If the

speed of sound is $340m/s$, what is the frequency of the whistle?

Watch Video Solution

32. A tuning fork P of unknows frequency gives 7 beats in 2 seconds with another tuning fork Q. When Q runs towards a wall with a speed of $5m/s$ it gives 5 beats per second with its echo. On loading P with wax, it gives 5 beats per second with Q . What is the

frequency of P? Assume speed of sound = $332m/s$.

Watch Video Solution

33. A stationary observer receives sonic oscillations from two tuning forks one of which approaches and the other recedes with the same velocity. As this takes place, the observer hears the beats of frequency $f = 2.0H_Z$. Find the velocity of each tuning fork if their oscillation frequency is

$f_o = 680 H_Z$ and the velocity of sound in air is $v = 340 m / s$.

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34. Sound waves from a tuning fork A reacha point P by two separate paths ABP and ACP. When ACP is greater than ABP by $11.5 cm$, there is silence at p. When the difference is $23 cm$ the sound becomes loudest at P and $34.5 cm$ there is silence again and so on. Calculate the minimum frequency of the

fork if the velocity of sound is taken to be $331.2m/s$.

Watch Video Solution

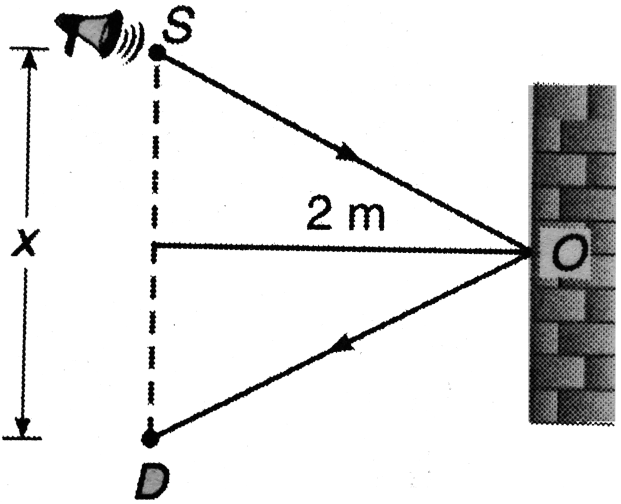
35. Two loudspeakers S_1 and S_2 each emit sounds of frequency $220H_Z$ uniformly in all directions. S_1 has an acoustic output of $1.2 \times 10^{-3}W$ and S_2 has $1.8 \times 10^{-3}W$. S_1 and S_2 vibrate in phase.Consider a point P such that $S_1P = 0.75m$ and $S_2p = 3m$. How are the phases arriving at P related? What is

the intensity at P when both S_1 and S_2 are on ? Speed of sound in air is $330 m / s$.

Watch Video Solution

36. A source of sound emitting waves at $360 H_Z$ is placed in front of a vertical wall, at a distance $2m$ from it. A detector is also placed in front of the wall at the same distance from it. Find the minimum distance between the source and the detestor for which the detector detects a maximum of sound. Take

speed of sound in air $= 360m/s$. Assume that there is not phase change in reflected wave.



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37. The atomic mass of iodine is $127g/mol$. A standing wave in iodine vapour at $400k$ has

nodes that are $6:77cm$ apart when the frequency is $1000H_Z$. At this temperature, is iodine vapour monatomic or daiatomic.

Watch Video Solution

38. A tuning fork whose natural frequency is $440H_Z$ is placed just above the open end of a tube that contains water. The water is slowly drained from the tube while the tuning fork remains in place and is kapt vibrating. The sound is found to be echanced when the air

column is $60cm$ long and when it is $100cm$ long . Find the speed of sound in air.

Watch Video Solution

39. A piano wire A vibrates at a fundamental frequency of $600H_Z$. A second identical wire B produces 6 beats per second with it when the tension in A is slightly increased. Find the ratio of the tension in A to the tension in B.

Watch Video Solution

40. A tuning fork of frequency $256 H_Z$ produces 4 beats per second with a wire of legth $25 cm$ vibrating in its fundamental mode. The beat frequency decrease when the length is slightly shortened. What could be the minimum length by which the wire be shortened so that it produces no beats with the tuning fork?

Watch Video Solution

41. Show that when the speed of the source and the observer are small compared to the speed of sound in the medium, the change in frequency becomes independent of the fact whether the source is moving or the observer.

 Watch Video Solution

42. A sound source moves with a speed of $80m/s$ relative to still air toward a stationary listener. The frequency of sound is $200H_Z$ and

speed of sound in air is $340 m / s$. (a) Find the wavelength of the sound between the source and the listener. (b) Find the frequency heard by the listener.

Watch Video Solution

43. A railroad train is travelling at $30 m / s$ in still air. The frequency of the note emitted by the node emitted by the locomotive whistle is $500 H_Z$. What is the wavelength of the sound waves : (a) in front of the locomotive?

What is the frequency of the sound heard by a stationary listener (b) behind the locomotive? (c) in front of the locomotive ? Speed of sound in air $344 m / s$. (d) behind the locomotive ?

Watch Video Solution

44. For a certain organ pipe, three successive resonance frequencies are observer at $425, 595$ and $765 H_Z$ respectively. Taking the speed of sound in air to be $340 m / s$, (a) explain

whether the pipe is closed at one or open at boyh ends. (b) determine the fundamental frequency and length of the pipe.

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45. Two tuning forks A and B sounded together give 8 beats per second. With an air resonance tube closed at one end, the two forks give resonances when the two air columns are $32cm$ and $33cm$ respectively. Calculate the frequenciec of forks.

Watch Video Solution

Subjective Questions

1. A uniform tube of length $60cm$ stands vertically with its lower end dipping into water . First two air column lengths above water are $15cm$, when the tube resonds to a vibrating fork of frequency $500H_Z$. Find the lowest frequency to the tube will respond when it is open at both ends.

View Text Solution

Level 2 Single Correct

1. A plane weve of sound travelling in air is incident upon a plane water surface. The angle of incidence is 60°. If velocity of sound in air and water are $330m/s$ and $1400m/s$, then the wave undergoes

A. refraction only

B. reflection only

C. Both reflection and refraction

D. neither reflection nor refraction

Answer: B

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2. An organ pipe of $(3.9\pi)m$long, open at both ends is driver to third harmonic standing wave. If the amplitude of pressure oscillation is 1% of mean atmospheric pressure $\left[p_o = 10^5 N/m^2\right]$. The [Given, velocity of

sound $= 200m/s$ and density of air $= 1.3kg/m^3]$

A. $2.5cm$

B. $5cm$

C. $1cm$

D. $2cm$

Answer: A

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3. A plance sound waves passes from medium 1 into medium2. The speed of sound in medium 1 is $200m/s$ and in medium 2 is $100m/s$. The ratio of amplitude of the transmitted waves to that of incident waves is

A. $\frac{3}{4}$

B. $\frac{4}{5}$

C. $\frac{5}{6}$

D. $\frac{2}{3}$

Answer: D

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4. A sounding body emitting a frequency of $150H_Z$ is dropped from a height. During its fall under gravity it crosses a balloon moving upwards with a constant velocity of $2m/s$ one second after it started to fall . The difference in the frequency observer by the man in balloon just before and just afer crossing the body will be (velocity of sound $= 300m/s$, $g = 10m/s^2$)

A. 12

B. 6

C. 8

D. 4

Answer: A

 Watch Video Solution

5. A closed organ pipe has length L. The air in it is vibrating in third overtone with maximum

amplitude. The amplitude at distance $\frac{L}{7}$ from closed of the pipe is

A. 0

B. a

C. $\frac{a}{2}$

D. Date insufficient

Answer: B

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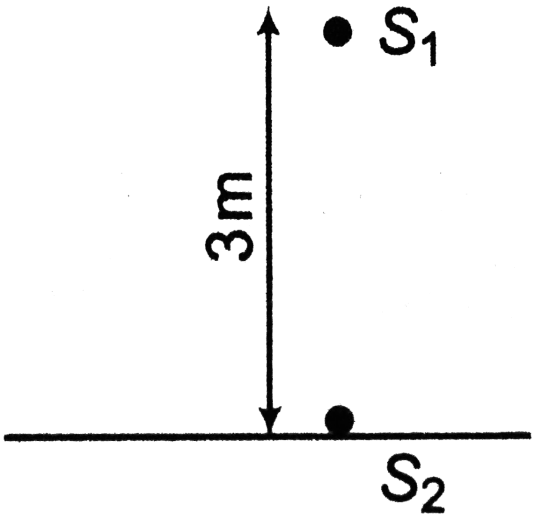
6. S_1 and S_2 are two coherent sources of sound having no intial phase difference. The velocity of sound is $330m/s$. No maximum will be formed on the line passing through S_2 and prependicular to the line joining S_1 and S_2. If the frequency of both the sources is



A. $330 H_Z$

B. $120 H_Z$

C. $100 H_Z$

D. $220 H_Z$

Answer: C

Watch Video Solution

7. A source is moving with constant speed $v_s = 20 m/s$ towards a stationary observer due east of the source. Wind is blowing at the

speed of $20m/s$ at 60° north of east. The source has frequency $500H_Z$. Speed of sound $= 300m/s$. The frequency resgistered by the observer is approximately

A. $541H_Z$

B. $552H_Z$

C. $534H_Z$

D. $512H_Z$

Answer: C

Watch Video Solution

8. A car travelling towards a hill at $10m/s$ sound its horn which a frequency $500H_Z$. This is heard in a second car travelling behind the first car in the same direction with speed $20m/s$. The sound can also be heard in the second car by reflections of sound the hill. The beat frequency heard by the driver of the sound car will be (speed of sound in air $= 340m/s$)

A. $31H_Z$

B. $24H_Z$

C. $21H_Z$

D. $34H_Z$

Answer: A

Watch Video Solution

9. Two sounding bolies are producing progressive waves given by $y_1 = 2\sin(400\pi t)$ and $y_2 = \sin(404\pi t)$ where t is in second,

which superpose near the ears of a persion. The person will hear

A. $2beats/s$ with intensity ratio $9/4$ between maximum and minima

B. $2beats/s$ with intensity ratio 9 between maximum and minima

C. $4beats/s$ with intensity ratio 16 between maximum and minima

D. $4beats/s$ with intensity ratio $16/9$ between maximum and minima

Answer: B

Watch Video Solution

10. The air in a closed tube $34cm$ long is vibrating with two nodes and two antinodes and its temprature is $51^\circ C$. What is the wavelength of the waves produced in air outside the tube, when the temperature of air is $16^\circ C$?

A. $42.8cm$

B. $68cm$

C. $17cm$

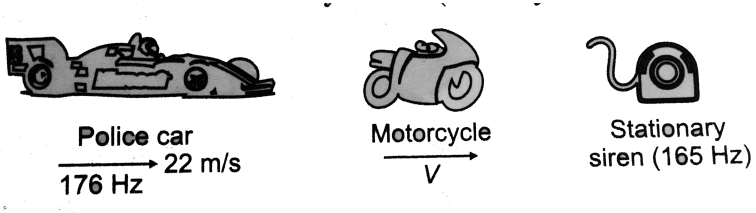
D. $102cm$

Answer: A

Watch Video Solution

11. A police car moving at $22m/s$, chase a motoclist. The police man has horn at $176H_Z$, While both of them move towards a stationary siran of frequency $165H_Z$. Calulate the speed

of the motorcyclist, if he does not observer any beats. (velocity of sound in air $= 330m/s$)



A. $33m/s$

B. $22m/s$

C. zero

D. $11m/s$

Answer: B

Watch Video Solution

12. A closed organ pipe resonates in its fundamental mode at a frequency of $200 H_Z$ with O_2 in the pipe at a certain temperature. If the pipe now contains 2 moles of O_2 and 3 moles of ozone, then what will be fundamental frequency of same pipe at same temperature?

A. $268.23 H_Z$

B. $175.4 H_Z$

C. $149.45 H_Z$

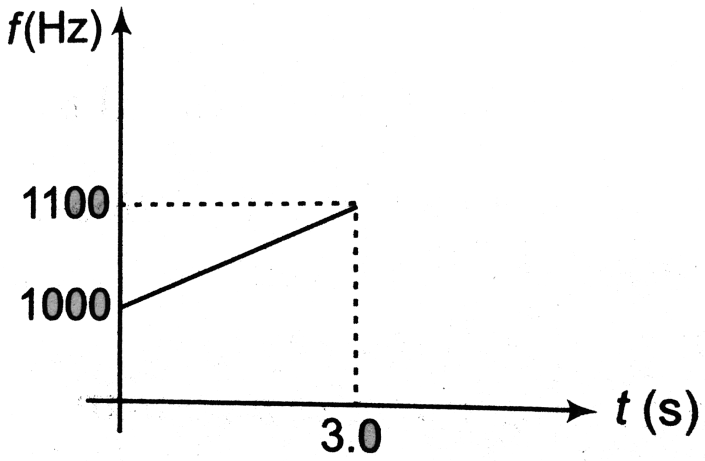
D. none of these

Answer: B

Watch Video Solution

13. A detector is released from rest over a source of sound of frequency $f_o = 10^3 H_Z$. The frequency observer by the dececter at time t is plotted in the graph. The speed of

sound in air $\left(g = 10m/s^2\right)$



A. $330m/s$

B. $350m/s$

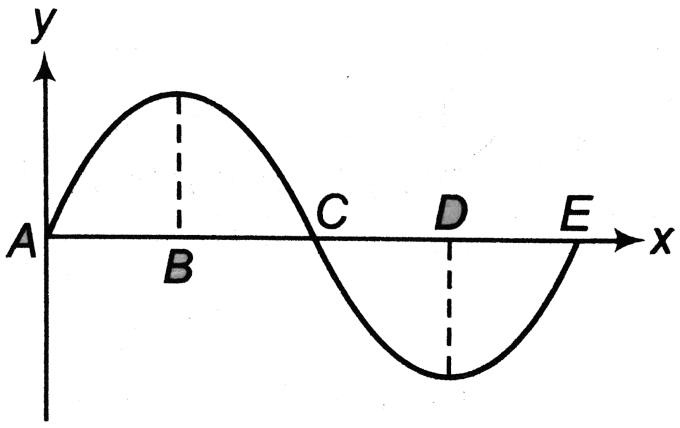
C. $300m/s$

D. $310m/s$

Answer: C

Watch Video Solution

14. Sound waves are trqvelling along positive x - direction. Displacement of particle at any time t is as shows in figure. Select the wrong statement.



A. Particle located at E has its velocity in negative $x-$ direction

B. Particle locted at D has zero velocity

C. Both (a) and (b) are correct

D. Both (a) and (b) are wrong

Answer: C

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Single Correct Option

1. Most people interpret a $9.0dB$ increase in sound intensity level as a doubling in loudness. By what factor must the sound intensity be increase to double the loudness?

A. $1m/s$

B. $2m/s$

C. $3m/s$

D. $4m/s$

Answer: B

View Text Solution

Level 2 More Than One Correct

1. An air column in a pipe, when is closed at one end, is in resonance with a vibrating tuning fork of frequency $264 H_Z$. If $v = 330 m/s$, the length of the column in cm is (are)

A. 31.25

B. 62.50

C. 93.75

D. 125

Answer: A::C

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2. Choose the correct options for longitudinal wave

A. maximum pressure variation is BAK

B. maximum displacement variation is ρAK

C. pressure equation and displacement equation are phase

D. all of the above

Answer: D

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3. Second overtons frequency of a pipe and fourth harmonic frequency of an pipe are same. Then, choose the correct options.

A. Fundamental frequency of closed pipe is more than the fundamental frequency of open pipe

B. First overtone frequency of closed pipe is more than the first overtone frequency of open pipe

C. Fifteenth harmonic frequency of closed pipe is equal to twelfth harmonic frequency of open pipe

D. Tenth haromic frequency of closed pipe is equal to eigth harmonic fequency of open pipe

Answer: B::C::D

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4. For fundamental frequency f of a closed pipe, choose the correct options.

A. If radius of pipe is increased, f will decrease

B. If temperature is increased, f will increase

C. If modecular mass of the gas filled in the pipe is increased, f will decrease.

D. If pressure of gas (filled in the pipe) is increased without change in tempreature, $f$will remain unchanged

Answer: A::B::C::D

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5. A source is approaching towards an observer with constant speed along the line joining them. After crossing the observer, source recedes from observer with same speed. Let f is apparent frequency heard by observer. Then,

A. f will keep on increasing during approaching

B. f will keep on decreasing during receding

C. f will remain constant during apporaching

D. f will remain constant during receding

Answer: C::D

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More Than One Correct Options

1. Which of the following is//are correct?

A. 

B. 

C. 

D. 

Answer: C::D

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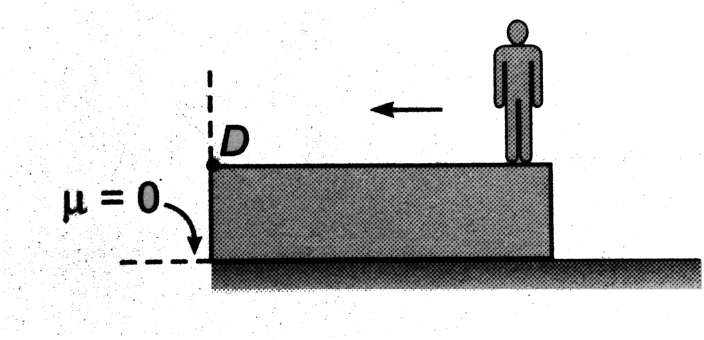
Level 2 Comprehension Based

1. A man of mass $50kg$ is runing on a plank of mass $150kg$ with speed of $8m/s$ relative to plank as shows in the figure (both were initially at rest and velocity of man with respect to ground any how remains constant). Plank is placed on smooth horizontal surface. The man, while runing, whistle with frequency f_o. A detected (D) placed on plank detects frequency. The man jumps off with same velocity (w.r.t. to groung) from point D and slides on the smooth horizontal surface [Assume coefficient of friction between man

and horizontal is zero]. The speed of sound in still medium is $330 m / s$. Answer the following questions on the basis of above situations.



The frequency of sound detected by detector D, before man jumps of the plank is

A. $\frac{332}{324} f_o$

B. $\frac{330}{322} f_o$

C. $\frac{328}{336} f_o$

D. $\frac{330}{338} f_o$

Answer: A

Watch Video Solution

Comprehension Based Questions

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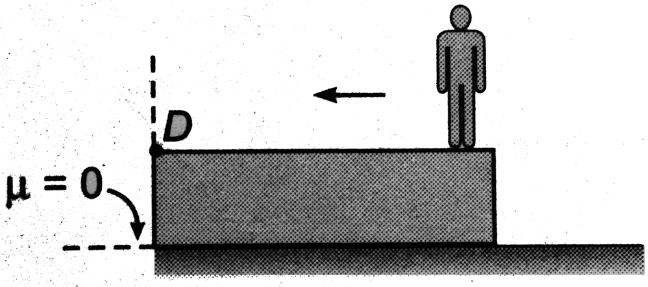

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D. $\frac{330}{338} f_o$

Answer: C

View Text Solution

2. A man of mass $50kg$ is runing on a plank of mass $150kg$ with speed of $8m/s$ relative to plank as shows in the figure (both were initially at rest and velocity of man with respect to ground any how remains constant). Plank is placed on smooth horizontal surface. The man, while runing, whistle with frequency f_o. A detected (D) placed on plank detects frequency. The man jumps off with same velocity (w.r.t. to groung) from point D and

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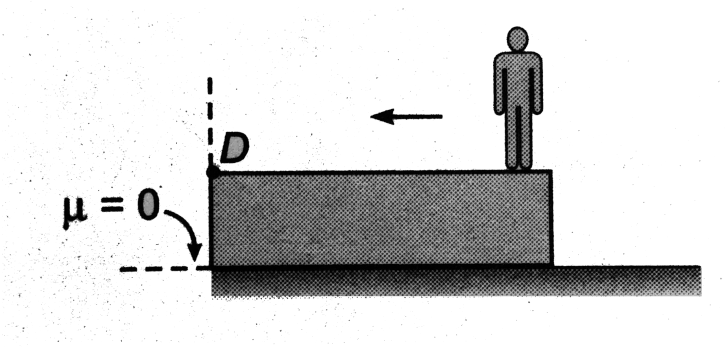
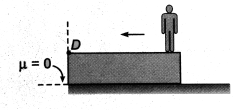


Choose the correct plot between the frequency the frequency detected by detector usrsus position of the man relative to detector.

A. 

B.

C.

D.

Answer: A

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Level 2 Subjective

1. A window whose area is $2m^2$ opens on a street where the street noise results at the window an intensity level of $60dB$. How much acoustic power energy from the street will it collect in a day?

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2. A point A is located at a distance $r = 1.5m$ from a point source of sound of frequency $600H_Z$. The power of the source is $0.8W$.

Speed of sound in air is $340m/s$ and density of air is $1.29kg/m^3$. Find at the point A, (a) the pressure oscillation amplitude$(\Delta p)_m$ (b) the displacement oscillation amplitude A.

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3. A flute which we treat as a pipe open at both ends is $60cm$ long. (a) What is the fundamental frequency when all the holes are covered? (b) How far from the mouthpieces should a hole be uncovered for the

fundamental frequency to be $330H_Z$? Take speed of sound in air as $340m/s$.

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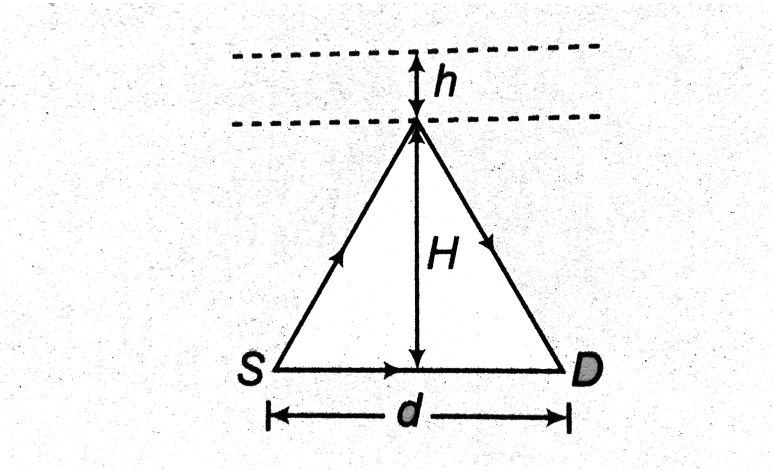
4. A source S and a detector D high frequency waves are a distance d apart on the ground. The direct wave from S is found to be in phase at D with the wave from S that is reflected from horizontal layer at an altitude H. The incident and reflected rayes make the same angle with the reflecting layer. When the layer

rises a distance h, no signal is detected at D . Negle ct absorption in the atmosphere and find the relation between d,h, H and the wavelength λ of the waves.



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5. Two sound speakers are driver in phase by an audio amplifier at frequency $600 H_Z$. The speed of sound is $340 m / s$. The speakers are on the y- axis, one at $y = +1.0 m$ and the other at $y = -1.0 m$. A listener begins at $y = 0$ and walks along a line parallel to the y - axis at a very large distance x away.

(a) At what angle θ (between the line from the origin to the listener at the x - axis) will she first hear a minimum sound intensity?

(b) At what angle will she first hear a maximum (afer $\theta = o^\circ$) sound intensity?

(c) How many maxima can she possible hear if she keeps walking in the same direction?

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6. Two speakers separeted by some distance emit sound of the same frequency. At some point P the intensity due to each speaker separately is I_o. The path difference from P to one of the speakers is $\frac{1}{2}\lambda$ greater than that from P to the other speaker. What is the intensity at P if

(a) the speakers are coherent and in phase,

(b) the speakers are incoherent, and

(c) the speakers are coherent but have a phase different of 180° ?

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7. Two loudspeakers radiate in phase at $170 H_Z$. An observer sits at $8m$ from one speaker and $11m$ from the other . The intensity level from either speaker acting alone is $60dB$. The speed of sound is $340m/s$.

(a) Find the observer intensity when both speakers are on together.

(b) Find the observer intensity level when both speakers are no together but one has its leads reversed so that the speakers are 180° out of phase.

(c) Find the observer intensity level when both speakers are on and in phase but the frequency is $85 H_Z$.

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8. Two identical speakers emit sound waves of frequency $680 H_Z$ uniformly in all directions with a total audio output of $1mW$ each. The speed of sound in air is $340m/s$. A point P is a distance $2.00m$ from one speaker and $3.00m$ from the other.

(a) Finf the intensity I_1 and I_2 from rach speaker at point p separately.

(b) If the speakers are driven coherently and in phase, what is the intensity at point p?

(c) If they driven coherently but of phase by 180°, what is the intensity at point P?

(d) If the speakers are incoherent, what is the intensity at point p?

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9. A train of length l is moving with a constant speed v along a circular track of radius R. The engine of the train emits a sound of frequency f. Find the frequency heard by a guard at the rear end of the train.

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10. A $3m$ long organ pipe open at both ends is driven to third harmonic standing wave. If the ampulitude of pressure oscillations is 1 per cent of mean atmospheric pressure $\left(p_o = 10^5 Nm^2\right)$. Find the ampulited of particle displacement and density oscillations. Speed of sound $v = 332m/s$ and density of air $\rho = 1.03kg/m^3$.

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11. A siren creates a sound level of $60H_Z$ at a location $500m$ from the speaker. The siren is powered by a batter that delivers a total energy of $1.0kJ$. Assuming that the efficiency of siren is $30\,\%$, determine the total time the siren can sound.

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12. A cylinder of length $1m$ is divided by a thin perfectly flexible diaphragm in the middle. It is

closed by similar flexible diaphragams at the ends. The two chambers into which it is divided contain hydrogen and oxygen. The two diaphragms are set in vibrations of same frequency. What is the minimum frequency of these diaphragms for which the middle diaphragm will be motionless? Velocity of sound in hydrogen is $1100 m / s$ and that in oxygen is $300 m / s$.

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13. A conveyor belt moves to the right with speed $v = 300m/s$. A very fast pieman puts pies on the belt at a rate of 20 per minute and they are recived at the other end by a pieeater.

(a) If the pieman is stationary find the spacing x betweenthe pies and the frequency with which they are recived by the stationary pieeater.

(b) the pieman now walks with speed $30m/\min$ towards the reciver while continuing to put pies on the recived by the stationary pieeater.

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14. A point sound source is situated in a medium of dulk modulus $1.6 \times 10^5 N/m^2$. An observer standing at a distance $10m$from the source writes down the equeation for the wave as $y = A\sin(15\pi x - 6000\pi t)$. Here y and x are in meter and t is in second. The maximum pressure ampulitude received to the observer's ear is (24π) pa, then find.

(a) the density of the medium,

(b) the displacement ampulitude A of the

wave recived by the observer and

(c) the power of the sound source.

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15. Two sources of sound S_1 and S_2 vibrate at same frequency and are in phase. The intensity of sound detected at a point P as shown in the figure is I_0 . (a) If θ equals 45°, what will be the intensity of sound detected at this point if one of the sources is switched off ? (b) What will be the answer of the previous part if

$\theta = 60^\circ$?

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16. Two narrow cylindrical pipes A and B have the same length. Pipe A is open at both ends and is filled with a monoatomic gas of molar mass M_A. Pipe B is open at one end and closed at the other end, and is filled with a diatomic gas of molar mass M_B. Both gases are at the same temperature.

(a) If the frequency of the second harmonic of the fundamental mode in pipe A is equal to the frequency of the third harmonic of the fundamental mode in pipe B, determine the value of M_B / M_B.

(b) Now the open end of pipe B is also closed (so that the pipe is closed at both ends). Find the ratio of the fundamental frequency in pipe A to that in pipe B.

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17. A boat is travelling in a river with a speed $2m/s$. From this boat, a sound transmitter is lowered into the river through a rigid support. The wavelength of the sound emitted from the transmitter inside the water is $14.45mm$. Assume that attenuation of sound in water and air is negligible.

(a) What will be the frequency detected by a receiver kept inside the river downstream?

(b) The transmitter and the receiver are now pulled up into air. the air is blowing with a speed $5m/s$ in the direction opposite the

river stream. Determine the frequency of the sound detected by the receiver.

(Temperature of the air and water = $20^{\circ}C$, Density of river water $= 10^{3}kg/m^{3}$, Bulk modulus of the water $= 2.088 \times 10^{9}$Pa, gas constant $R = 8.31J/mol - K$, Mean molecular mass of air $= 28.8 \times 10^{-3}kg/mol$, C_P/C_V for air $= 1.4$)

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18. A string $25cm$ long and having a mass of $2.5gm$ is under tension. A pipe closed at one end is $40cm$ long. When the string is set vibrating in its first overtone and the air in the pipe in its fundamental frequency, 8 beats per second are heard. It is observed that decreasing the tension in the string decreases beat frequency. If the speed of sound in air is $320m/s$, find the tension in the string.

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19. A source of sound of frequency 1000 Hz moves to the right with a speed of $32\frac{m}{s}$ relative to the ground. To its right there is a reflecting surface moving to the left with a speed of $64\frac{m}{s}$ relative to the ground. Take the speed of $64\frac{m}{s}$. Relative to the ground. Take the speed of sound in air to be $332\frac{m}{s}$ and find

(a) The wavelength of the sound emitted in air by the source,

(b) the number of waves per second arriving at the reflecting surface,

(c) The speed of the reflected waves and

(d) The wavelength of the reflected waves.

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Exercise 19 1

1. Calculate the bulk modulus of air from the following data about a sound wave of wavelength 35 cm travelling in air. The pressure at a point varies between $\left(1.0 \times 10^{5} \pm 14\right)$ Pa and the particles of the

air vibrate in simple harmonic motion of amplitude` 5.5 x 10^-5m.

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2. Find the minimum and maximum wavelengths of sound in water that is in the audible range (20-20000 Hz) for an average human ear. Speed of sound in water $= 1450ms^{-1}$.

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3. A typical loud sound wave with a frequency of $1Kh_Z$ has a pressure amplitude of about 10 Pa

(a) At $t = 0$, the pressure is a maximum at some point X_1. What is the displacement at that point at $t = 0$?

(b) What is the maximum value of the displacement at any time and place/ Take the density of air to be $1.29kg/m^3$ and speed of sound in air is $340m/s$.

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4. The pressure variation in a sound wave in air is given by

$$\Delta p = 12 \sin(8.18X - 2700t + \pi/4) N/m^2$$

find the displacement amplitude. Density of air $= 1.29 kg/m^3$.

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Exercise 19 2

1. At what temperature will the speed of sound be double of its value at $0^{\circ} C$?

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2. Calculate the difference in the speeds of sound in air at $-3^{\circ} c$,$60cm$ pressure of mercury and $30^{\circ} c$, $75cm$ pressure of mercury. The speed of sound in air at $0^{\circ} C$ is $332m / s$.

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3. In a liquid with density $900kg/m^3$, lonfitudinal waves with frequency $250H_Z$ are found to have wavelength $8.0m$. Calculate the bulk modulus of the liquid.

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4. Calculate the speed of sound in oxygen at $273K$.

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Exercise 19 3

1. A sound wave in air has a frequency of $300 H_Z$ and a displacement ampulitude of $6.0 \times 10^{-3} mm$. For this sound waves calculate the (a) Pressure ampulitude (b) intensity (c) Sound intensity level (in dB)

Speed of sound $= 344 m/s$ and density of air $= 1.2 kg/m^3$.

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2. Most people interpret a $9.0dB$ increase in sound intensity level as a doubling in loudness. By what factor must the sound intensity be increase to double the loudness?

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3. A baby's mouth is $30cm$ from her father's ear and $3.0m$ from her mother's ear. What is the difference between the sound intensity levels heard by the father and by the mother.

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4. The faintest sound that can be heard has a pressure ampulitude of about $2 \times 10^{-5} N/m^2$ and the loudest that can be heard without pain has a pressure ampulited of about $28 N/m^2$. Dentermine in each (a) the intensity of the sound both in w/m^2 and in dB and (b) the ampulited of the oscillations if the frequency is $500 H_Z$. Assume an air density of $1.29 kg/m^3$ and a velocity of sound is $345 m/s$.

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Exercise 19 4

1. Two sound waves emerging from a source reach a point simultaneously along two paths. When the path difference is $12cm$ or $36cm$, then there is a silence at that point. If the speed of sound in air be $330m/s$, then calculate maximum possible frequency of the source.

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2. A wave of frequency $500Hz$ has a wave velocity of $350m/s$.

(a) Find the distance between two points which are $60\circ$ out of phase.

(b) Find the phase difference between two displacement at a certain point at time $10^{-3}s$ apart.

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Exercise 19 5

1. An open pipe is suddenly closed at one end with the result that the frequency of third harmonic of the closed pipe is found to be higher by $100Hz$ then the fundamental frequency of the open pipe. The fundamental frequency of the open pipe is

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2. An organ pipe P_1 open at one end vibrating in its first harmonic and another pipe P_2 open

at ends vibrating in its third harmonic are in resonance with a given tuning fork. The ratio of the length of P_1 to that P_2 is

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3. A tube, closed at one end and containing air, produces, when excited, the fundamental note of frequency $512Hz$. If the tube is open at both ands the fundamental frequency that can be excited is (in Hz)

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4. The fundamental frequency of a closed pipe is $220 H_Z$.

(a) Find the length of this pipe.

(b) The second overtone of this pipe has the same frequency as the third harmonic of an open pipe. Find the length of this open pipe. Take speed of sound in air $345 m / s$.

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5. An organ pipe has two successive harmonics with frequencies 400 and $560 H_Z$. The second of sound in air is $344 m / s$.

(a) Is the an open or a closed pipe?

(b) What two harmonics are three?

(c) What is the length of the pipe?

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Introductory Exercise

1. Standing sound waves are produced in a pipe that is $0.8m$ long, open at one end, and closed at th other. For the fundamental and first two overtone, where along the pipe (measured from the closed end) are

(a) the displacemental antinodes

(b) the pressure antinodes.

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Exercise 19 6

1. A tuning fork produces 4 beats per second with another tuning fork of frequency 256 Hz. The first one is now loaded with a little wax and the beat frequency is found to increase to 6 per second. What was the original frequency of the tuning fork ?

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2. A tuning fork of unknows frequency makes three beats per second with a standard fork of frequency $384 H_Z$. The beat frequency

decreases when a small piece of wax is put on a prong of the first fork. What is the frequency of this fork?

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Exercise 19 7

1. A whistle giving out $450H_Z$ approaches a stationary observer at a speed of $33m/s$. The frequency heard the observer (in H_Z) is (speed of sound $= 330m/s$)

A. 409

B. 429

C. 517

D. 500

Answer: D

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2. A train moves towards a stationary observer with speed $34m/s$. The train sounds a whistle and its frequency registered by the observer is

f_1. If the train's speed is reduced to $17m/s$, the frequency registered is f_2. If the speed of sound of $340m/s$, then the ratio f_1/f_2 is

A. $18/19$

B. $1/2$

C. 2

D. $19/18$

Answer: D

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3. A siren placed at a railway platform is emitting sound of frequency $5kHz$. A passenger sitting in a moving train A records a frequency of $5.5kHz$ while the train approaches the siren. During his return journey in a different train B he records a frequency of $6.0kHz$ while approaching the same siren. the ratio the velocity of train B to that of train A is

A. $242/252$

B. 2

C. $5/6$

D. $11/6$

Answer: B

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4. A train is moving on a straight track with speed $20ms^{-1}$. It is blowing its whistle at the frequency of $1000Hz$. The percentage change in the frequency heard by a person standing

near the track as the train passes him is (speed of sound $= 320 ms^{-1}$) close to :

A. $12\ \%$

B. $6\ \%$

C. $18\ \%$

D. $24\ \%$

Answer: A

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